Appendix C. Methodology for Microturbine/Combined Heat and Power (CHP) Outcomes

Microturbine/CHP Markets

As discussed in Section 2.3.3, one vendor reported worldwide sales of 16.5 MW of ETV-verified microturbines in the last year. Of these sales, the vendor reported that 52% were in the United States and 90% were for CHP applications (ETV Vendor, 2005). Based on these data, the ETV Program calculated current minimum market penetration as follows:

16.5 MW x 52% x 90% = 7.7 MW

This is a conservative (low) estimate because it includes sales by only one vendor during one year. The ETV Program used this minimum market penetration to calculate future penetration over the next five years as follows:

(16.5 MW x 52% x 90%) x 5 years = 38.6 MW

Adding this value to the current minimum penetration of 7.7 MW results in a total installed capacity of 46.3 MW. This estimate also is conservative (low) because it is based on the conservative estimate of current sales and assumes no growth in sales. The vendor forecasts sales will double this year and double again the following year (ETV Vendor, 2005). Also, various economic estimates of the microturbine/CHP market project an increasing market for these technologies, as discussed below.

EEA (2003) reports that current microturbine sales in CHP applications average 50 units per year. Assuming an average capacity per unit in the range reported for the ETV-verified technologies (30 to 75 kW), current sales as reported by EEA (2003) translate to 1.5 to 3.75 MW of capacity per year. The same source, however, estimates an increasing market for these technologies: 1,530 MW in CHP applications, both new and retrofit, over the next 20 years. This translates to sales of 76.5 MW per year. This latter estimate assumes advances in technology that result in greater efficiency and cost-effectiveness than achieved by current technology. Another estimate of the microturbine market can be derived from data in Boedecker et al. (2000). This source estimates microturbines will generate 1 billion kWh in 2010 and 3 billion kWh in 2020. The capacity required to generate this much electricity would be a minimum of 57 MW in 2010 and 171 MW in 2020.[56] This capacity increase would require microturbine sales of 114 MW over ten years, or 11.4 MW per year. Exhibit C-1 compares the estimates used in this analysis with the projections from these economic analyses. The estimates used in this analysis are at the lower end, but within,

56 These capacity estimates assume 100% utilization of installed capacity, and are, therefore, low.

EXHIBIT C-1

FIVE-YEAR MICROTURBINE/CHP MARKET ESTIMATES

Source	Sales per year (MW)	Total over five years (MW)	Comments/Limitations
EEA, 2003	1.5 to 3.75	7.5 to 18.8	Based on current sales averaged over the last 20 years. Includes CHP applications only.
Estimate used in ETV's analysis	7.7	38.6	Based on 2004 sales by a single vendor (ETV Vendor, 2005). Assumes no growth in sales. Includes CHP applications only.
Boedecker et al., 2000	11.4	57	Based on 100% capacity utilization. Assumes limited technology advancement.
EEA, 2003	76.5	383	Assumes technology advancement. Includes CHP applications only.

the range from the economic analyses.

Emissions Reductions

Emissions reductions from microturbine applications vary on a site-by-site basis. Because of this variation, quantitative data are not available to produce detailed nationwide estimates. To produce a rough estimate, the ETV Program calculated the total emissions reductions assuming all applications are identical and represented by model sites. The ETV Program examined several possible model sites, all developed by Southern Research Institute in the verification reports for the technologies. Exhibit C-2 summarizes the model sites examined. The verification reports (Southern Research Institute, 2001a, 2003a, 2003b) describe the model sites and the baseline assumptions (e.g., displaced conventional power source) used to generate the reduction estimates in more detail. For the estimates in this analysis, the ETV Program used only the first two sites in Exhibit C-2 for the following reasons:

- the estimates for these sites are based on actual test site operations (as opposed hypothetical sites)
- the estimates include both CO_2 and NO_X reductions
- the estimates were developed using more recent assumptions about displaced emissions rates

The ETV Program generated upper- and lower-bound estimates for CO_2 and NO_X by

EXHIBIT C-2

MODEL SITES EXAMINED IN ESTIMATING EMISSIONS REDUCTIONS

Location and Facility Type	Site Capacity (kW)	Site CO_2 Reduction (pounds per year)	Site NO_X Reduction (pounds per year)	Source
New York, Community Center (e)(1)	70	212,000	1,330	Southern Research Institute, 2003a
New York, Supermarket (e)(2)	60	328,000	1,060	Southern Research Institute, 2003b
Chicago, Large Office (h)	60	527,000	Not estimated	Southern Research Institute, 2001a
Chicago, Medium Hotel (h)	60	558,000	Not estimated	Southern Research Institute, 2001a
Chicago, Large Hotel (h)	90	884,000	Not estimated	Southern Research Institute, 2001a
Chicago, Hospital (h)	420	3,920,000	Not estimated	Southern Research Institute, 2001a
Atlanta, Large Office (h)	60	1,050,000	Not estimated	Southern Research Institute, 2001a
Atlanta, Medium Hotel (h)	60	1,160,000	Not estimated	Southern Research Institute, 2001a
Atlanta, Large Hotel (h)	90	1,700,000	Not estimated	Southern Research Institute, 2001a
Atlanta, Hospital (h)	420	9,770,000	Not estimated	Southern Research Institute, 2001a

Notes: (h) hypothetical site, (e) ETV test site, (1) used to generate lower-bound CO_2 estimates and upper-bound NO_X estimates, (2) used to generate upper-bound CO_2 estimates and lower-bound NO_X estimates.

choosing the model sites that result in the highest and lowest CO_2 and NO_X reductions, respectively. The national estimates use the following equation:

$$TR = (TC / MC) \times MR / 2000$$

Where:

- TR is total CO_2 or NO_X reduction in tons per year
- TC is the total capacity in MW of ETV-verified microturbines installed and varies depending on the market penetration scenario
- MC is the model site capacity in MW and varies depending on the model site chosen
- MR is model site CO_2 or NO_X reduction in pounds per year and varies depending on the model site chosen